Exemplar® Plus

Smart CCD Spectrometer
User Manual

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Exemplar® Plus

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1. Introduction

The Exemplar® Plus is the next generation in the evolution of the miniature CCD spectrometers featuring on-board data processing and USB 3.0 communication. The Exemplar Plus is also optimized for multi-channel operation featuring ultra-low trigger delay, ultra-low gate jitter, and super speed data transfer. Additionally, the Exemplar Plus features a 2048 element detector, and built-in 16-bit digitizer with a >400 kHz readout speed.

2. Exemplar Spectral Acquisition Modes

There are three spectral acquisition modes as described below.

2.1.Normal Scan Mode

In this acquisition mode the spectrometer acquires data which is received by the PC/Software through the USB. The user can then perform post data manipulation such as Averaging, Smoothing and Dark Compensation. Continuous spectra acquisition is possible in Normal Scan Mode. At an integration time of 6.0ms the maximum frame rate is less than 40 spectra per second in this mode.

2.2.Smart Scan Mode

Smart Scan allows for data manipulation to take place in the Exemplar's on-board processor including Averaging, Smoothing and Dark Compensation, in that order. The user has the ability to send a command with flags for each of the methods. The internal data processing engine can handle any combination of these methods.

Table 1 details the frame rate at different combinations of methods at an integration time of 1ms.

Processing	**Estimated Time Needed**
Smoothing	23.5 (ms)
Dark Compensation	7.2 (ms)
Averaging N time	T = 28.03(ms) x N + 10.35 (ms)

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2.3.Burst Scan Mode

This is the fastest spectral acquisition mode. After a burst mode spectral acquisition command is received, the internal spectral acquisition engine will continuously send the spectra back to the PC until the preset number of spectra is reached. In this mode the minimum integration time must be set to 6ms, as the events of signal integration and spectral readout plus sending of data are processed simultaneously. There is no time gap between the consecutive integration periods, which enables this spectrometer to be a suitable device for time-of-flight event capturing.

In this mode, the maximum frame rate can reach 149 frames per second at an integration time of 6ms.

3. Specifications

See Product Data Sheets for specifications for the Exemplar Plus, Model BTC655.

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4. Check Contents

Before installation please check your system contents. They may include:

- Exemplar Plus Spectrometer unit
- USB 3.0 Cable
- AUX Port Cable
- BWSpec4™ software CD

Exemplar Plus Spectrometer

USB 3.0 Cable

BWSpec4™ Software CD

Aux Port Cable

5. Installation

Software / Hardware Installation

There is a BWSpec Installation Guide located on your software CD. Refer to this guide for full installation instructions

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6. Operating Software BWSpec Quick Start Guide

6.1. Getting to know BWSpec graphic user interface

The BWSpec operating software has a graphic user interface which consists of a menu bar, quick access bar, graphic area, message bar and control panel.
Reference the BWSpec4™ User Manual located on your Software CD for more information on how the software works.

6.2. Quick Start

1. Run BWSpec from the shortcut icon that will have been placed on your desktop after installation.

2. From the toolbar, select “Acquire Continuously”

3. Aim the spectrometer’s SMA Port (Light Input) towards a broadband light source; for example a tungsten bulb, light bulb, or overhead lights.

4. You should see a spectral response being displayed on the Graph in the BWSpec4™ software window, if not adjust (increase) the integration time from the toolbar.

Note: There are different ways in which light can be directed into the spectrometer’s SMA Port and different light sources which can be used.

For more information on these types of setups, please visit our website: www.bwtek.com.

Multiplier Function
When using the Exemplar Plus Spectrometer, the ‘Multiplier’ function is not available and will be greyed out:

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7. Auxiliary Port Function

Exemplar is capable of monitoring and controlling both digital and analog signals through the Auxiliary Port on the side of the spectrometer. The table below is the description and function details for each pin of the Auxiliary Port. These standard functions are accessible through SDK. Moreover, if the customer wants to create their own input/output correlations, B&W Tek can configure a customized pin definition.

Go to **Appendix B – Aux Port** for Pins Assignments

8. Hardware Setup

The Exemplar allows for advanced hardware control features which can be found:
Menu Bar → Setup → Hardware Setup…
Click on the “BTC655 Aux Port” tab

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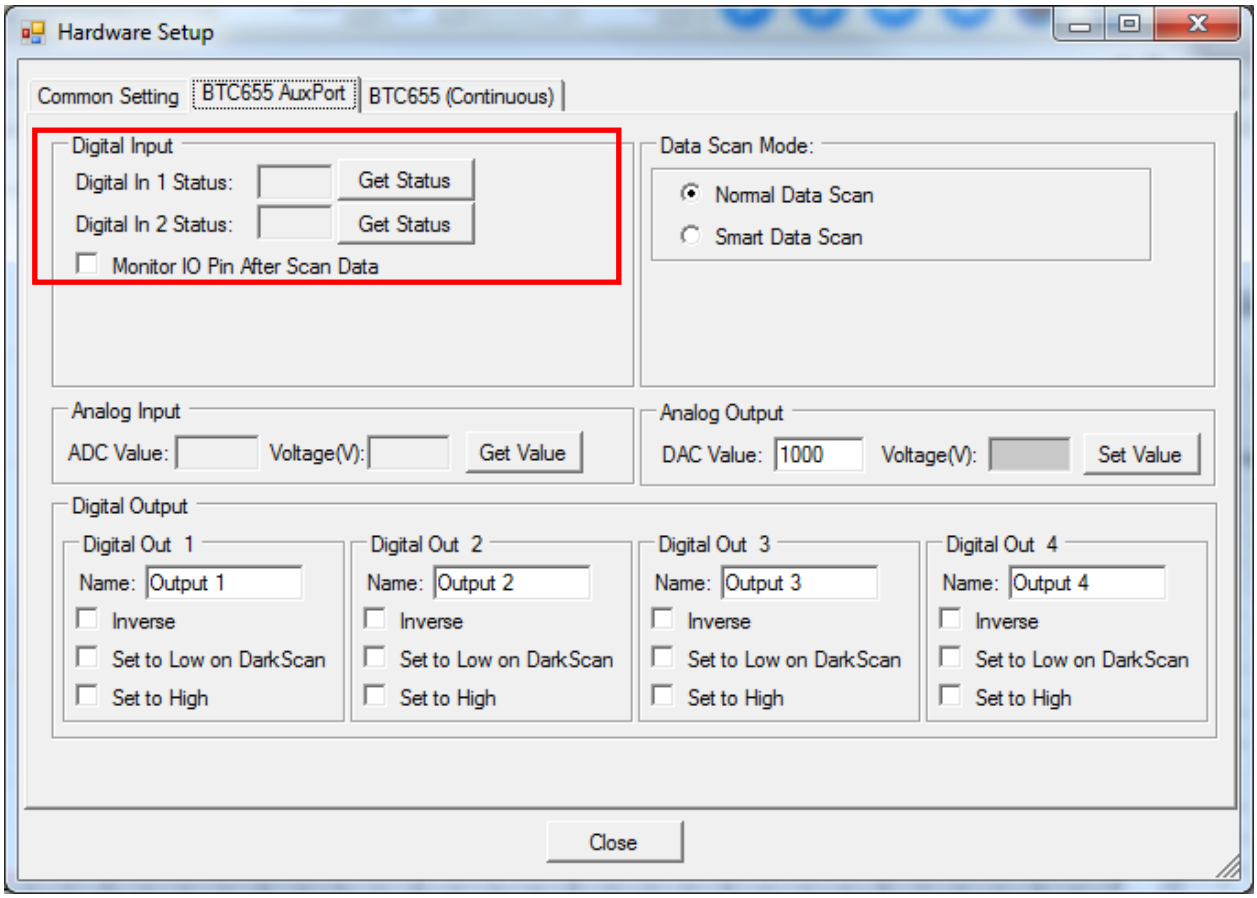
8.1.Digital Input Section:



The **"Get Status"** button will return a 'High' or 'Low' value depending on the TTL Digital Signal being applied to the 'Digital In 1' and 'Digital In 2' pins.

Monitor IO Pin After Scan: when enabled the Status of the 'Digital In 1' and 'Digital In 2' pins will be updated after each scan. The Digital In 1 Status and Digital In 2 Status will be displayed below the graph in the main BWSpec Window. Statuses will appear after the first acquisition. Location will vary depending on the size of the main BWSpec window.

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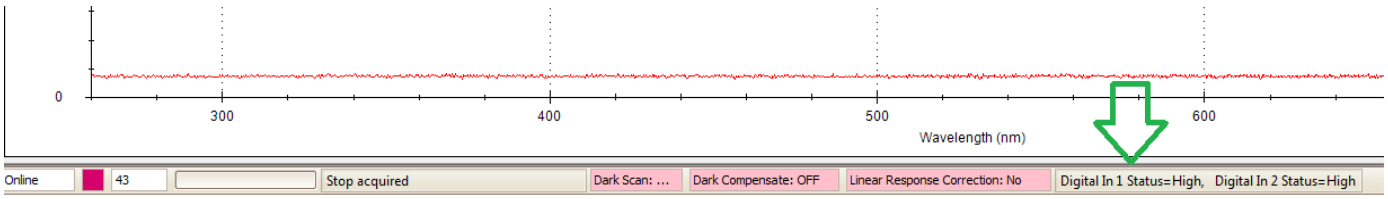
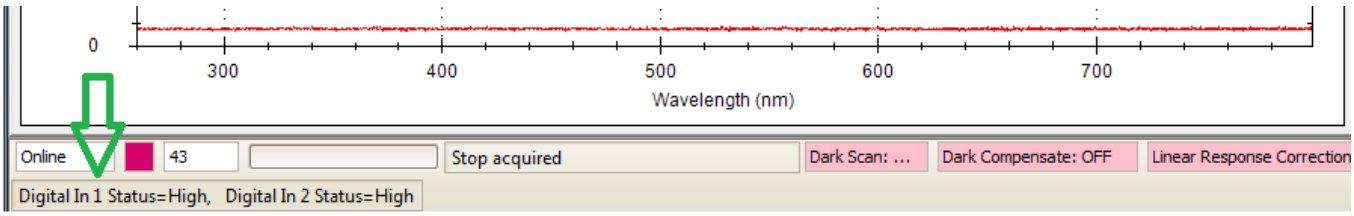
"Full Screen" Window display



"Reduced"/"Minimized" Window display



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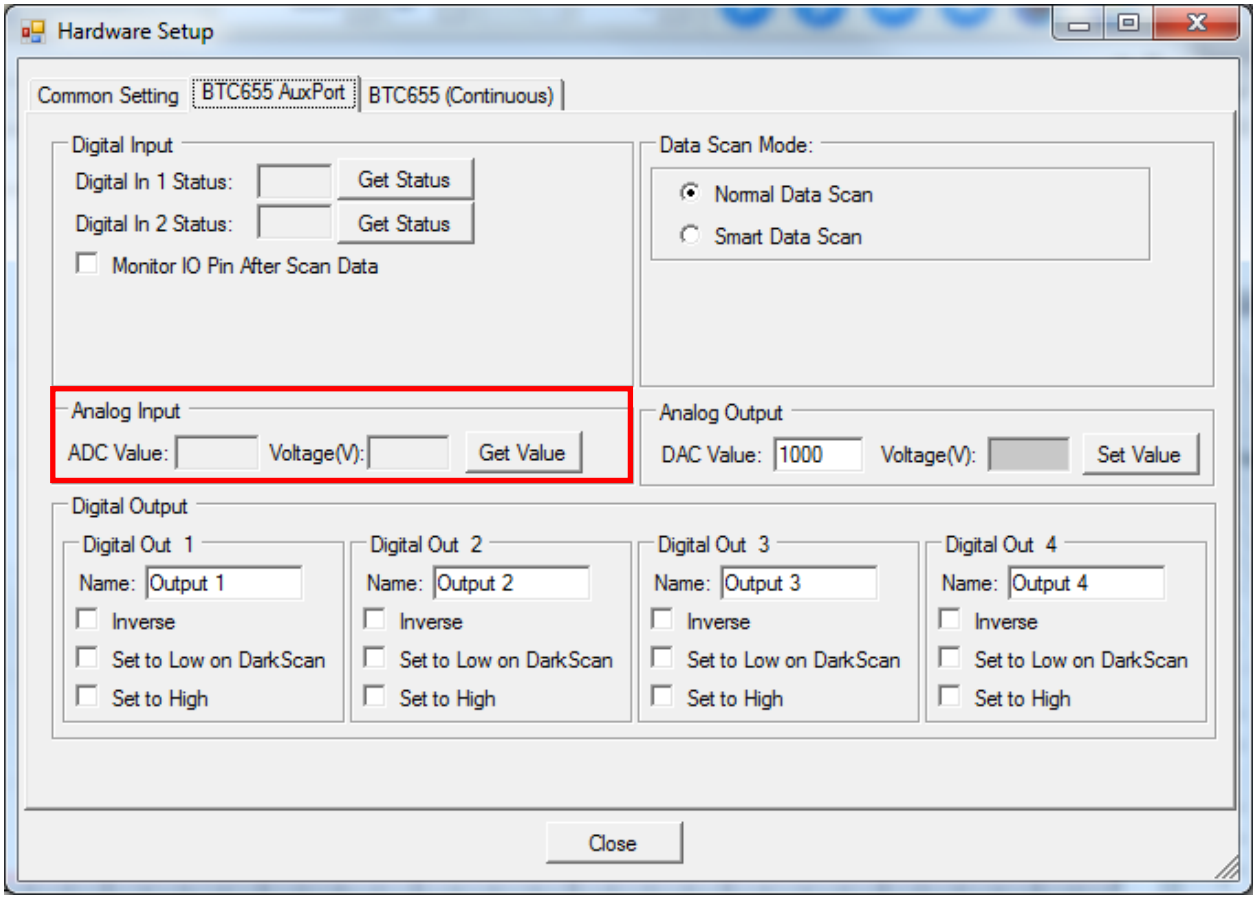
8.2. Analog Input Section:



ADC Value: will return the Digital value of the Analog signal applied to the 'Analog Input' pin.
*ADC Value = (Voltage / 2.28) * 1024*

Voltage (V): will return the Analog Voltage value of the Analog signal applied to the 'Analog Input' pin.
*Voltage = (ADC Value / 1024) * 2.28*

(Reference the "Auxiliary Port Function" section in this User Manual)

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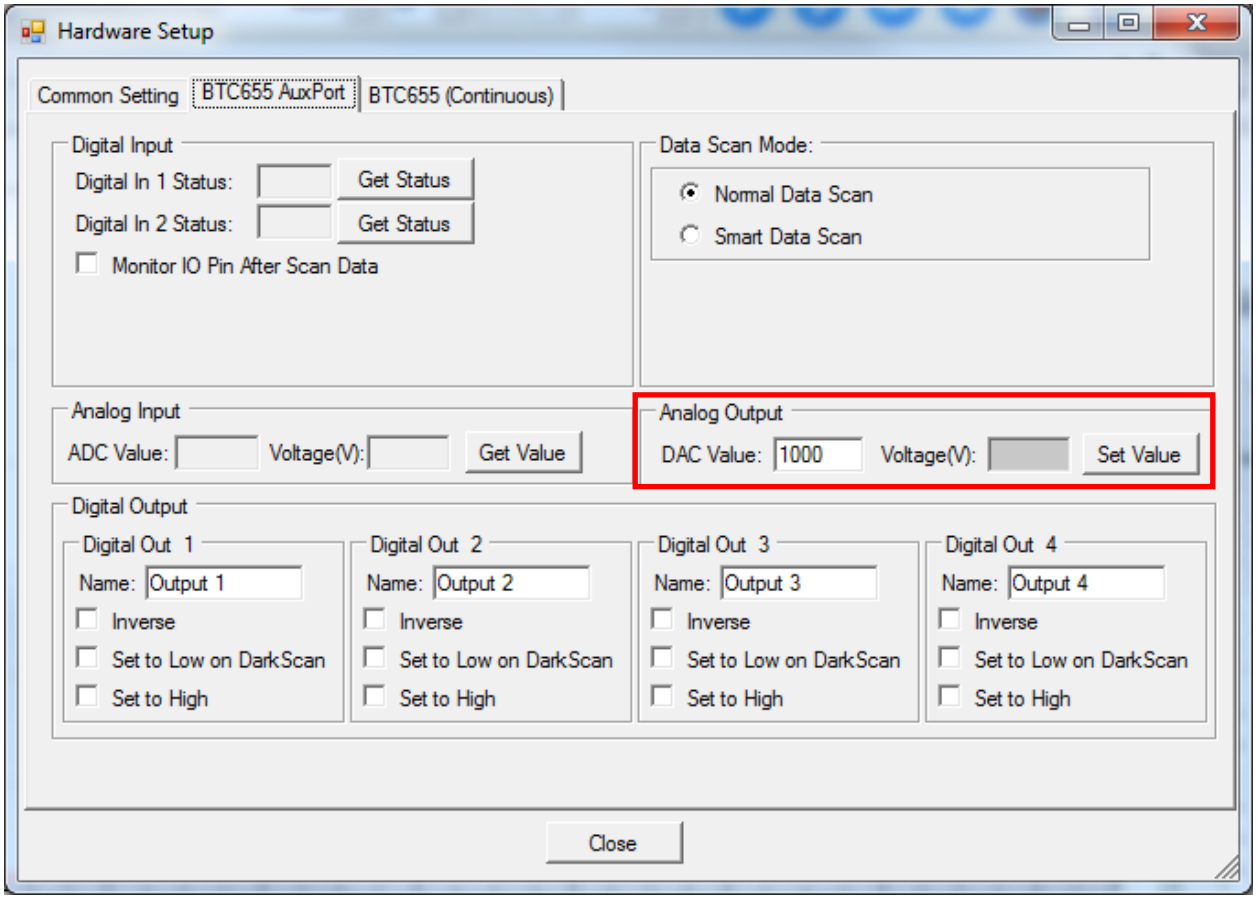
8.3. Analog Output Section:



DAC Value: can be set to a 12-bit Digital signal Range from 0 – 4095 when the 'Set Value' button is pressed. This will output a voltage range of 0 – 2.28 Volts to the 'Analog Output' pin. *Voltage = (DAC Value / 4096) * 2.28*

(Reference the "Auxiliary Port Function" section in this User Manual)

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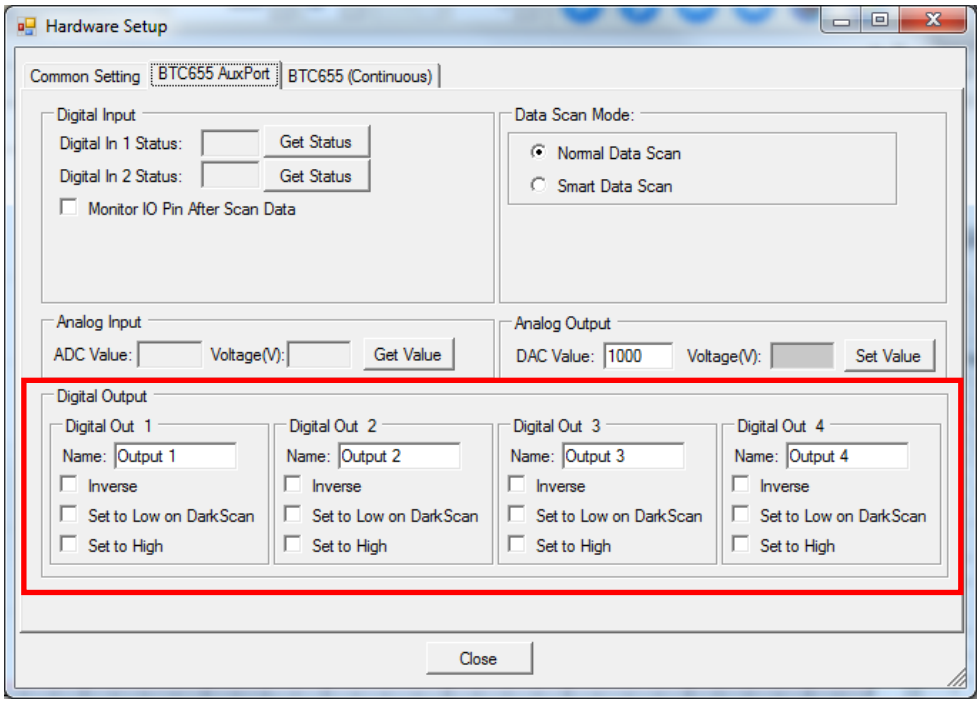
8.4.Digital Output Section:



'Digital Out 1' – 'Digital Out 4' sections relate to the corresponding 'Digital Out #' pin on the Auxiliary Port.

(Reference the "Auxiliary Port Function" section in this User Manual)

- **'Name:'** field can be renamed to an application appropriate function, which will be displayed under the 'Acquire Control' section the BWSpec 4 Main Window.
- **Inverse Checkbox:** When activated, inverts the output status.
- **Set to Low on DarkScan:** This will Output the configured signal through the corresponding Digital Out Pin when a 'Dark Scan' is taken in BWSpec. (For Example, you could use this to Close an External Shutter)
- **Set to High**: By Default the Output Signals are set to LOW. When checked, the Output is set to HIGH through the corresponding Digital Out Pin. When enabled the checkbox status will also be reflected under the 'Acquire Control' section the BWSpec4 Main Window.
  Reference the following 'True Table' for Output Signal configurations.

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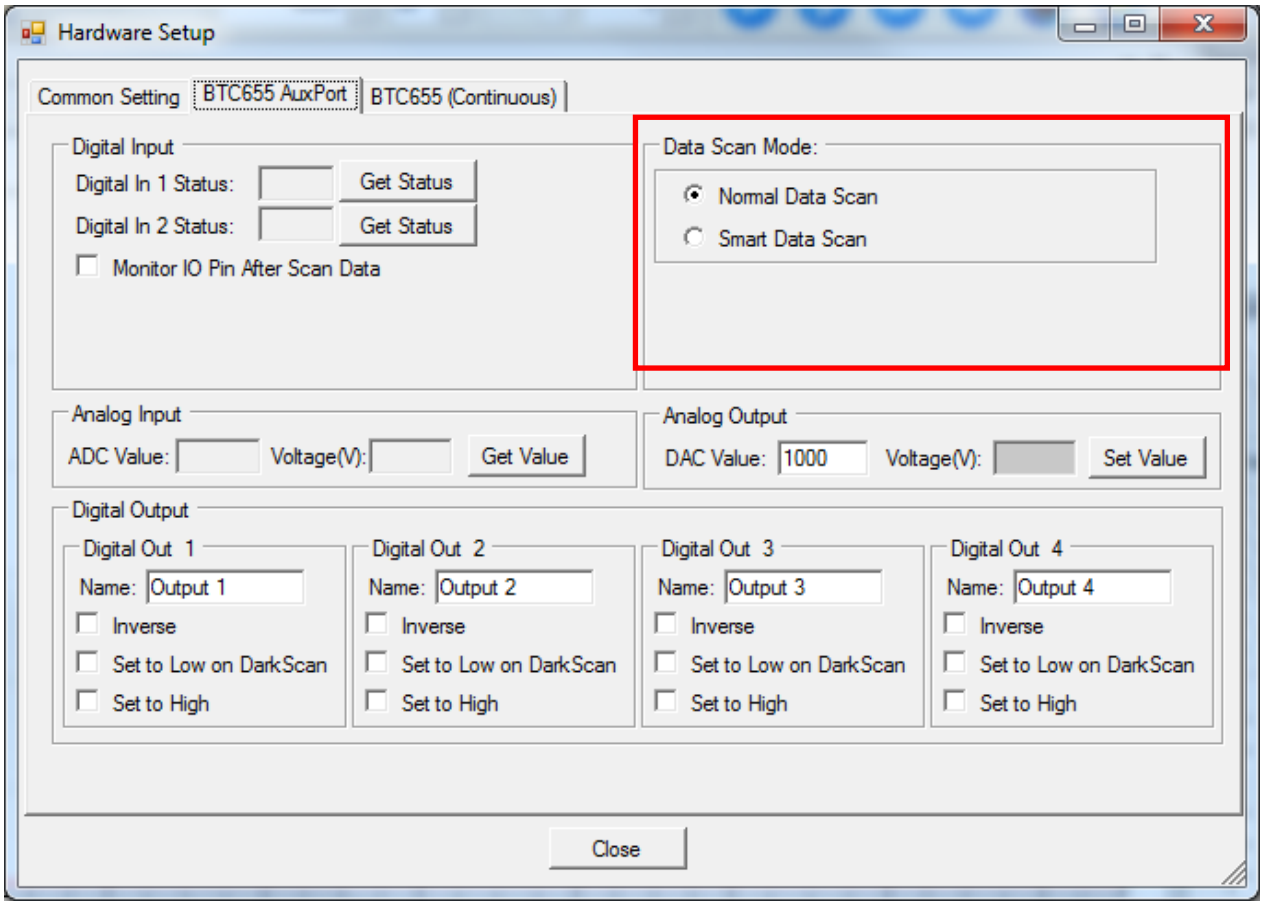
True Table:

Inverse Check Box	Set to High Check Box	Output (**0 = LOW, 1 = HIGH**)
0	0	0
0	1	1
1	0	1
1	1	0

8.5.Data Scan Mode Section:



The Exemplar has three data scan modes, **Normal Scan, Smart Scan** and **Burst Scan**.

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8.5.1. Normal Data Scan

Normal Data Scan, when selected, allows the spectrometer to acquire and transmit data. Data manipulation is then accomplished by the software/computer, such as averaging, smoothing and dark compensate.

8.5.2. Smart Data Scan:

Smart Data Scan**,** allows for data manipulation to take place inside the spectrometer allowing for smart spectra acquisition. Smart Scan Features are:

- **Dark Compensate:** This will auto adjust the baseline of the spectrometer so that the dark current is auto removed from the collected data.
- **Average:** You can run average scanning where x number of scans will be taken at the given integration time, and then the average of all these scans will be displayed in BWSpec
- **Smooth:** Smoothing will be applied to all data outputted to BWSpec.

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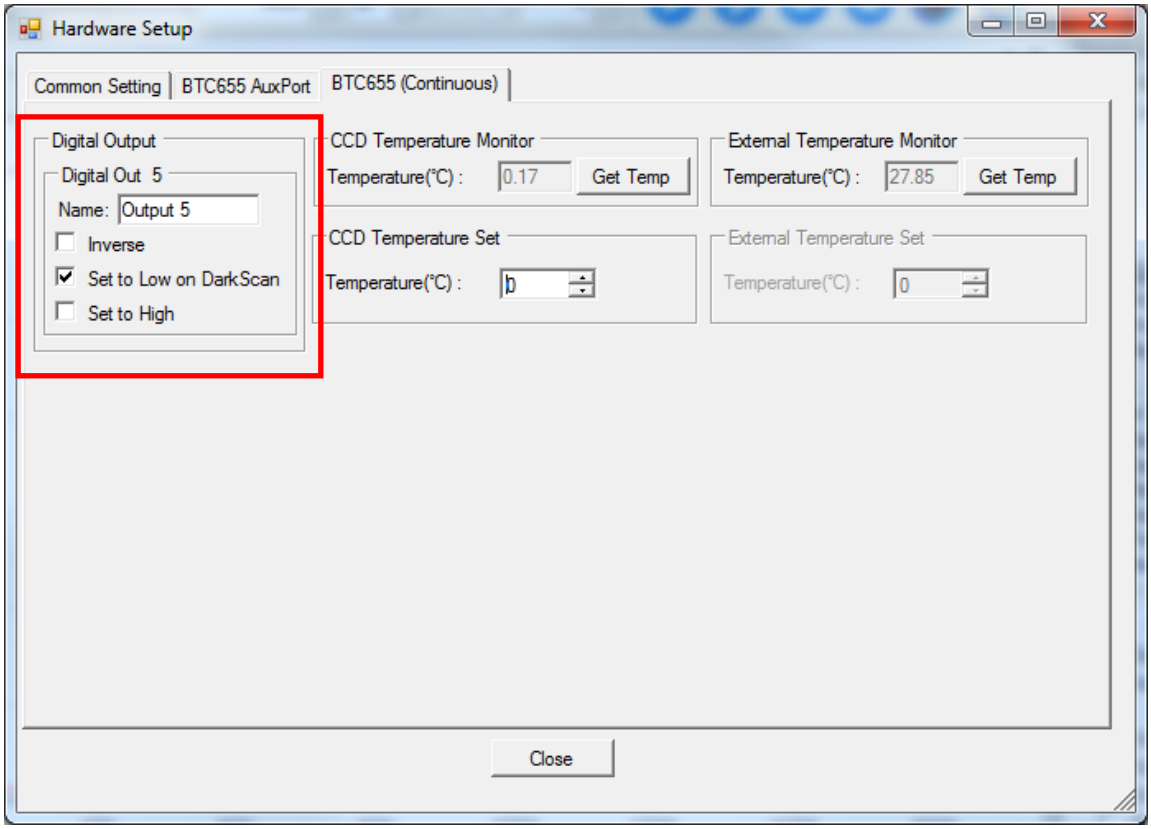
8.6.Digital Output, BTC655 (Continuous)-Tab



'Digital Out 5' – relates to the Internal Shutter of the spectrometer, which comes standard on all standard configuration Exemplar Plus spectrometers.

- **'Name:'** field can be renamed to an application appropriate function, which will be displayed under the 'Acquire Control' section the BWSpec 4 Main Window.
- **Inverse Checkbox:** When activated, inverts the output status.
- **Set to Low on DarkScan:** This will Output the configured signal through the corresponding Digital Out Pin when a 'Dark Scan' is taken in BWSpec. (For Example, you could use this to Close an External Shutter)
- **Set to High**: By Default the Output Signals are set to LOW. When checked, the Output is set to HIGH through the corresponding Digital Out Pin. When enabled the checkbox status will also be reflected under the 'Acquire Control' section the BWSpec4 Main Window.
  Reference the following 'True Table' for Output Signal configurations.

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True Table:

Inverse Check Box	Set to High Check Box	Output (**0 = LOW, 1 = HIGH)**
0	0	0
0	1	1
1	0	1
1	1	0

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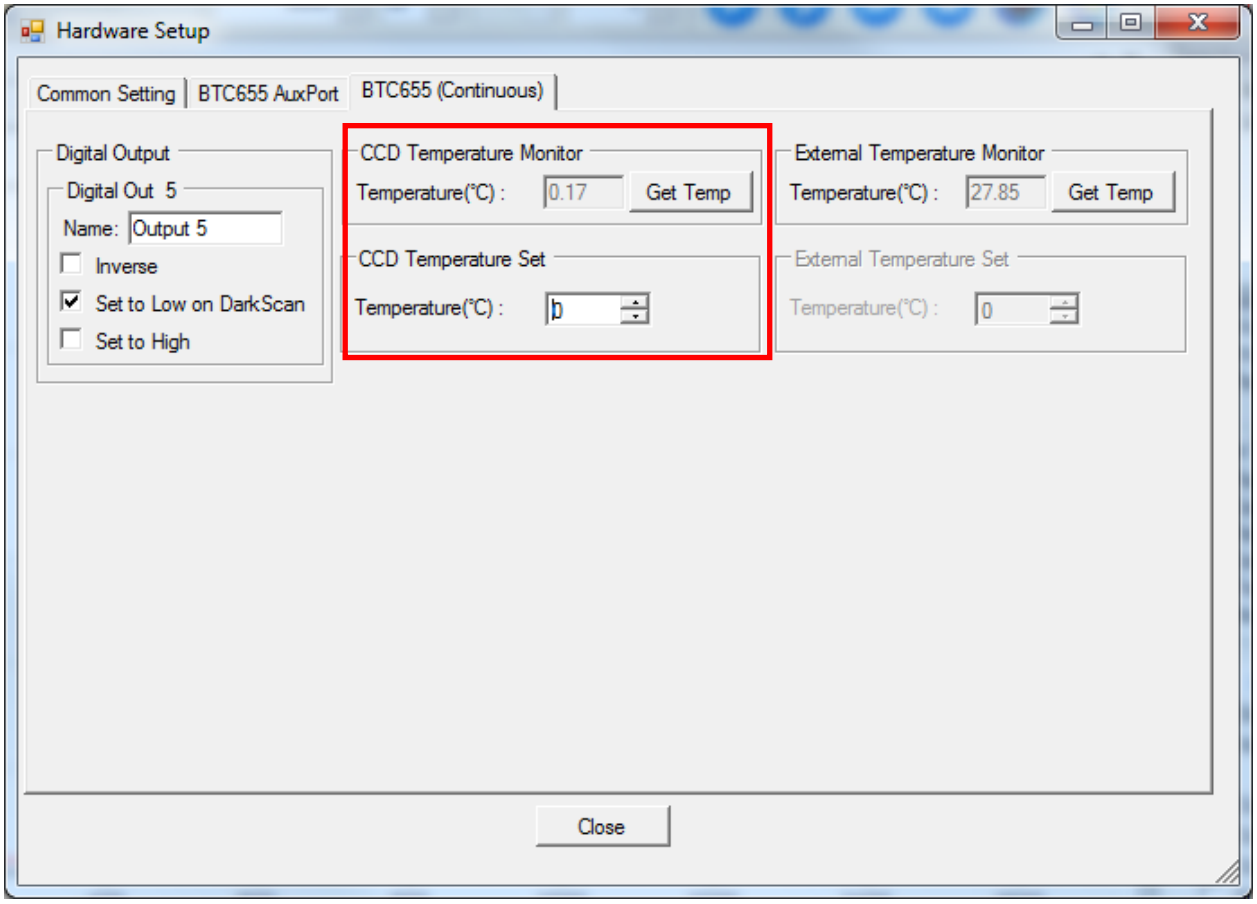
8.7.CCD Temperature Output, BTC655 (Continuous)-Tab



- **CCD Temperature Mointor:** Pressing the “Get Temp” button will display the current TEC Tempeature of the spectrometer’s detector.
- **CCD Temperature Set:** Using the upand down arrows the user can change the TEC Temperature setting of the spectrometer’s detector.
  - Changing the Temperature and then using the “Get Temp” button will displaay how close the Real TEC Temperature is to the set Temperature. The user may need to adjust the Set TEC Temperature in order to achieve the desired Real TEC Tempature. At a set temperature of 0 degrees the tolerance may be +/- 0.2 degrees C.

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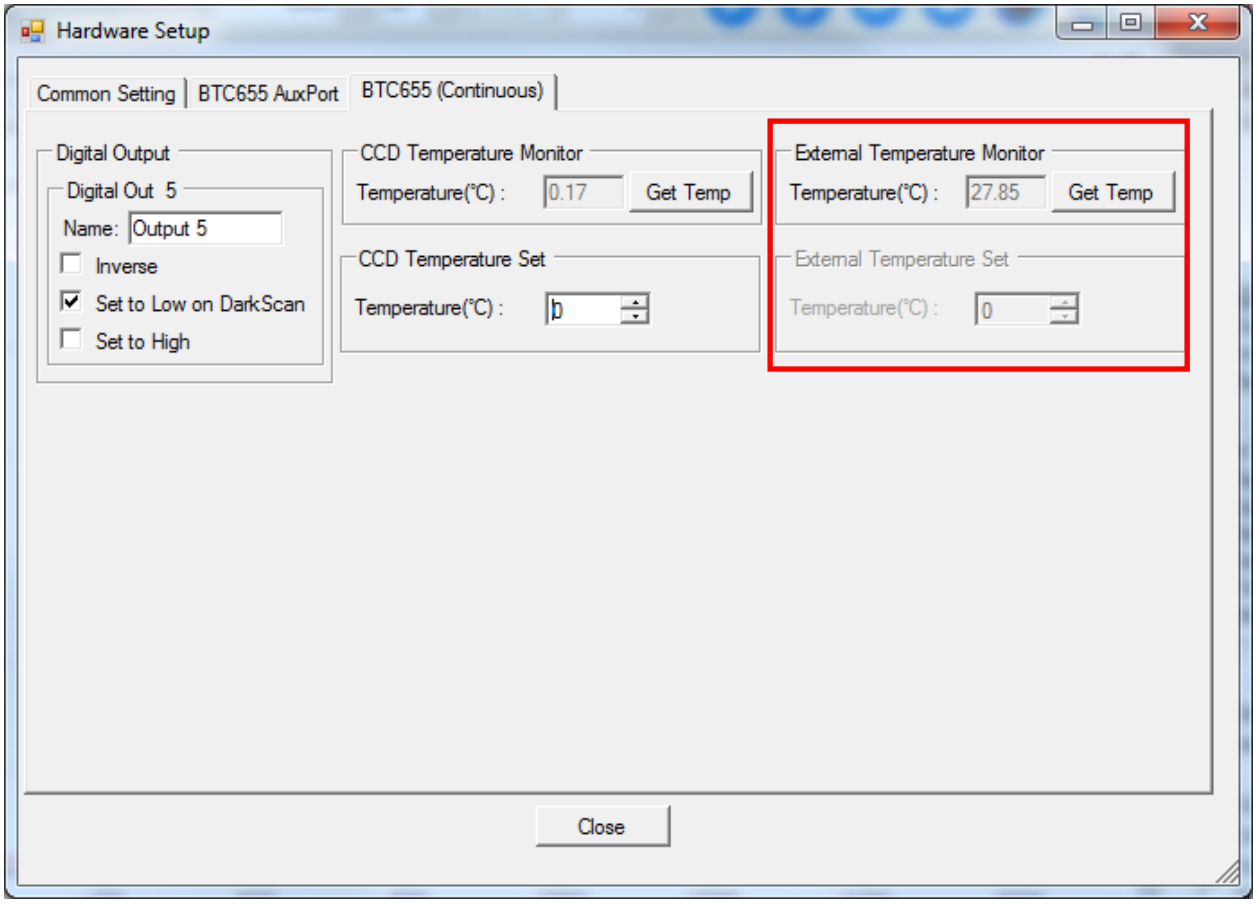
8.8. External Temperature Monitor, BTC655 (Continuous)-Tab



- **External Tempeature Monitor:** Pressing the “Get Temp” button will display the internal Tempeature of the housing.
- **External Tempeature Set:** This is Not used for this model spectrometer.

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8.9.Burst Data Scan

Burst Mode allows for the fastest data acquisition possible by the spectrometer by limiting overhead processing from data transfer to the computer and saving data. In Burst Mode the spectrometer will continuously acquire and transfer data to the PC without a time gap between successive spectra.

8.9.1. Burst Mode is located under the Timeline Plugin:

- **Enable the Timeline Plugin-**
  Menu Bar --> Plug-in --> Plug-in Manager...
  Locate the "Timeline Plug-in" and enable the Check box.
  Click "OK" to enable.

- **Open Timeline from the menu-**
  Menu Bar --> Tools --> Timeline --> Timeline (Equal Integration Time)...

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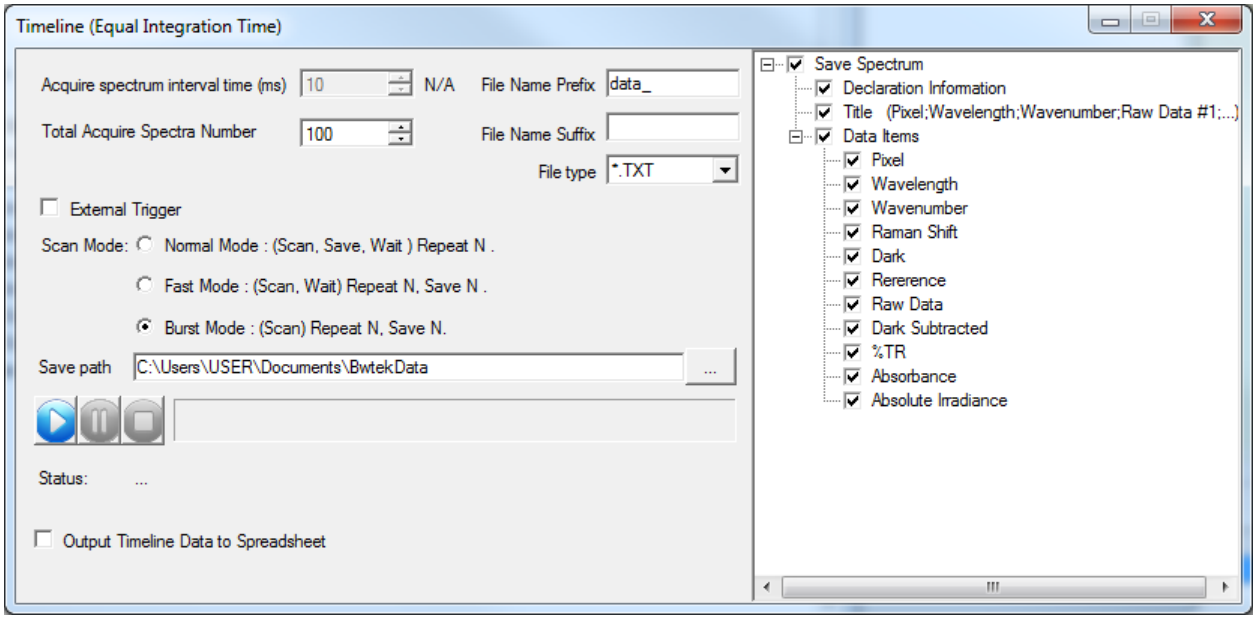
Notes:

- Burst Mode will only work with the Set integration Time >= 6000us, Multiplier = 1 and Averaging = 1 (6000us or 6ms is the minimum integration time allowed in Burst Mode).
- The highest number of scans the spectrometer can acquire is 16,000.
- Smart Data Scan cannot be used in conjunction with Burst Mode.
- "Time Average" from the Main BWSpec window will have No Effect when acquiring data.
- "Multiplier" from the Main BWSpec window will have No Effect when acquiring data.

8.9.2. Setup



- **Total Acquire Spectra Number:** This sets the number of scans to be performed by the spectrometer.
- **File Name Prefix:** This sets the prefix for the saved spectra
- **File Name Suffix:** This sets the suffix for the saved spectra
- **File type:** This sets the saved file type for the saved spectra.
  Options: .txt, .csv, .BwRam, .SPC
- **Save path:** This sets the location where the data will be saved once complete.
- Right Side of the window allows the user to select what specific data is to be saved.

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- These control the progress of the Burst Mode. Press the 'Play' button to begin acquiring.
- **Output Timeline Data to Spreadsheet:** This outputs the saved data to an Excel Spreadsheet.

Notes

1. You must have **MS Excel** installed on your computer for this feature to work.
2. **DO NOT click** on the excel worksheet while it is being written. This will disrupt the output process and you will lose the data.
3. For Outputting to Excel, you are **limited by the Max number of columns (6)** for the number of scan you can have outputted.

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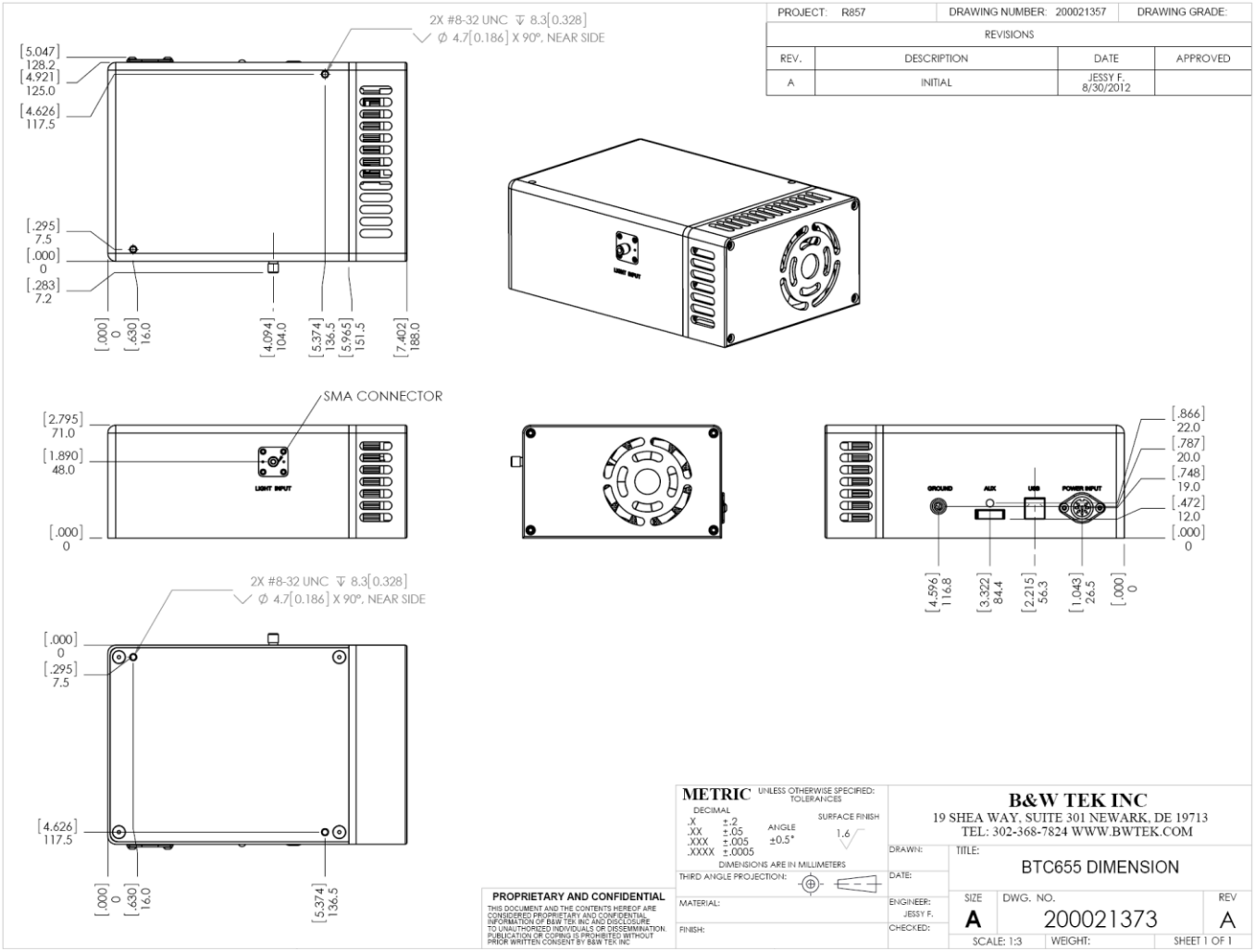
Appendix A: Dimensional Drawing – BTC655



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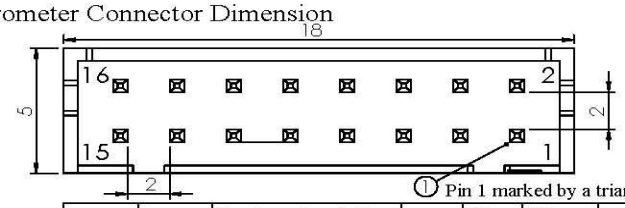
Appendix B: Aux Port

Table 1. Auxiliary Port Pin Assignments

Pin	IO	Description	Comment	Suggested Wire Color
1	Input	Device reset	Microcontroller hardware reset input and low level active. The minimum level low width is 1ms and minimum level high width is 5ms to guarantee proper reset function. Input high level 3.3V with internal 10k pull-up resistor.	Red
2	Input	Digital In1	TTL INPUT 1. TTL 5V compatible, standard high level input current 20mA, standard low level output current 20mA. Internal 10k pull-up resistor available.	Orange
3	Output	Digital Out1	TTL OUTPUT 1. TTL 5V compatible, standard high level output current 20mA, standard low level input current 20mA.	Yellow
4	Input	Digital In2	TTL INPUT 2. TTL 5V compatible, standard high level input current 20mA, standard low level output current 20mA. Internal 10k pull-up resistor available.	Green
5	Input	Analog In	10 bit resolution ADC using successive approximation method. The analog input range is 0~2.28V.	Brown
6	Input / Output	Ground	Ground	Black
7	Output	Digital Out 2	TTL OUTPUT 2. TTL 5V compatible, standard high level output current 20mA, standard low level input current 20mA.	Brown
8	Input	External trigger	External trigger pulse input. TTL 5V compatible. Falling edge effective. Recommended level low width is 30~100us. Internal 10k pull-up resistor available.	Red
9	Input / Output	Ground	Ground	Black
10	Output	Analog Out	12 bit resolution DAC using resistor ladder method. The analog output range is 0~2.28V.	Yellow
11	Output	Digital Out 3	TTL OUTPUT 3. TTL 5V compatible, standard high level output current 20mA, standard low level input current 20mA.	Green
12	Output	Digital Out 4	TTL OUTPUT 4. TTL 5V compatible, standard high level output current 20mA, standard low level input current 20mA.	Orange
13	Input	Shutter Power 1	Voltage supply for direct shutter control output 1. This pin should tie to the positive pin of the shutter.	Red
14	Input	Shutter Power 2	Voltage supply for direct shutter control output 2. This pin should tie to the positive pin of the shutter.	Red
15	Output	Shutter Control 1	This pin should tie to the negative pin of the shutter.	Green
16	Output	Shutter Control 2	This pin should tie to the negative pin of the shutter.	Orange

Figure 1. Spectrometer Connector Dimension



Dimensions are in mm[Inch]
Tolerances:
Fractional ±
Angular: Mach ± Bend ±
Two place decimal ±
Three place decimal ±

Material
Finish
Next | Used on
Application
DO NOT SCALE DRAWING

	Name	Date
Drawn	John Lu	November 29, 2012
Checked		
Eng. appr.		
MFG appr.		
Q.A.		
Comments:		

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http://www.bwtek.com/

Product: BTC655

Title: Aux. Port Pin Assignments

Size	FCSM NO.	DWG. NO.	Rev.
B		310000046	B

Scale: 2:1 | Weight | Code: SW12 | Sheet 1 of 1

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